Systems Designer

An occupational profile for the Heating, Refrigeration and Air Conditioning Industry

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SYSTEMS DESIGNER

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Heating, Refrigeration and Air Conditioning Industry

Ministry of Colleges and Universities

Hon. Harry C. Parrott, D.D.S., Minister
Dr. J. Gordon Parr, Deputy Minister

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PREFACE

This profile of the systems designer occupation within the heating, refrigeration and air conditioning (HRA) industry describes the occupation in terms of terminal performance objectives.

The profile was developed as part of a joint industry task analysis program conducted by the HRA industry and the provincial and federal governments. The program's goals were to establish which occupations make up the industry and to describe the tasks of each of these. Through the resultant occupational profiles it would set a performance standard for the industry in Ontario. It should also yield the following benefits:

- basis for effective training at all levels within the industry;
- a career plan with various entry and exit levels to meet individual requirements;
- a basis for common training programs across Canada with a national certification standard;
- a means of counselling students and attracting young people into a fast-growing industry;
- a means of improving communication between industry and the government on training matters.

The analysis of the HRA industry was carried out in Ontario by the Ministry of Colleges and Universities' Program Resources Branch under the guidance of a steering committee selected from a cross-section of the industry. This committee was chaired by W. F. Marshall, of Marshall Refrigeration Company Limited.

Field analysis teams supervised by G. I. Bruce and co-ordinated by G. F. Starink, both of the Ministry, began gathering information by means of interviews with the industry management staff and employees in late 1974. Using Statistics Canada data on the distribution of HRA companies across Ontario, and acting upon steering committee guidelines that covered differences such as geographic location, company size, and the number and types of company within each of the heating, refrigeration and air conditioning segments of the industry, the analysts chose 50 representative companies that would provide valid data.

The material in these occupational profiles comes from approximately 100 interviews conducted at these companies. Individual tasks that comprised each occupation within the industry were determined by asking the following questions:

. what does the worker do?
. how does the worker do it?
. why is he/she doing it?
. what are the skills and knowledge involved?
. what is the minimum standard of performance expected?

A task analysis of the data gathered resulted in the consolidation of 57 job titles found in the industry into 12 major occupations. The steering committee accepted the following occupational profiles:

. Refrigeration & Air Conditioning Mechanic (completed Dec./75).
. Counterclerk H.R.A. (completed Jan./76).
. Warehouseworker H.R.A. (completed Jan./76).
. Salesman/woman (completed Aug./76).
. Heating Servicer - Gas & Oil (completed Sept./77).
. Systems Designer.
. Design Draftsman (Intermediate, Junior).
. Estimator.
. Order Desk Clerk.
. Dispatcher.
. Purchasing Agent.

Those not completed are subject to on-going modification in title and content.

The Program Resources Branch wishes to acknowledge the support and assistance of the following members of the H.R.A. industry analysis steering committee:

W. F. Marshall (Chairman),	Marshall Refrigeration Co. Ltd.
H. Smith,	Ontario Sheet Metal & Air Handling Group.
P. Drabinsky,	Techaire Systems Inc. (representing the Ontario Refrigeration and Air Conditioning Contractors Association).
D. Geddes,	Heating, Refrigerating and Air Conditioning Institute of Canada.
G. Granek,	G. Granek & Associates.
J. W. Ingram,	Shell Canada Ltd. (representing the Ontario Petroleum Association).
W. Podd,	Mohawk College (representing the Refrigeration Service Engineers Society).
P. F. Reynolds,	Jenkinson & Co. Ltd. (representing the American Society of Heating, Refrigerating, Air Conditioning Engineers Inc.).
N. W. Walden,	Ontario Refrigeration & Air Conditioning Contractors Association.
D. R. Wheeler,	Lennox Industries (Canada) Ltd. (representing the Heating, Refrigeration & Air Conditioning Institute of Canada).
H. Anderson,	Public Works of Canada.

INTRODUCTION

The analysis of the HRA industry and ensuing occupational profiles contain only those phases of the industry considered essential in Ontario and are limited to the knowledge and skills agreed upon by the industry analysis steering committee. The scope of the material is, however, broad enough to cover the whole family of occupations in the HRA industry up to, but not including, professional or pure management levels. Breakdowns of the industry, and of the different occupational areas analyzed within it, are shown in the tables below.

BREAKDOWN OF THE INDUSTRY

HEATING	AIR CONDITIONING	REFRIGERATION
Domestic	Automotive	Mobile
Commercial	Residential	Marine
Gas	Commercial/Residential	Commercial
Oil		
Sheet Metal		
	Electrical	
	Plumbing	

BREAKDOWN OF OCCUPATIONAL AREAS

MANUFACTURING	SYSTEM DESIGN	DISTRIBUTION	INSTALLATION AND SERVICE
Applications Technician	Design Consultant	Applications Technician	Applications Technician
Sales Technician	Estimator	Sales Technician	Estimator
Telephone Order Desk	Design Draftsman	Purchasing	Sales Technician
		Order Desk	Field Inspector
		Counterman	Mechanic
		Order/Picker and/or Stockman	Purchasing
			Service Order Desk

SPECIFIC PERFORMANCE OBJECTIVES AND CRITERIA FOR

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
1	read catalogues, handbooks and manuals	select and apply engineering standards from various sources, for example: . ASHRAE guides and handbooks . HRAI manuals . accredited standards, writing organizations such as: - Canadian Gas Association - Canadian Government Specifications Board - Canadian Standards Association - Underwriters' Laboratories of Canada . Municipal, Provincial, and Federal Building Codes, Bylaws, etc. have an awareness of voluntary standards such as: . HRAI standards for heat pump equipment and installation, etc. interpret standard terms, symbols and codes used in heating, refrigeration, air conditioning and ventilation select and clarify general information on specifications of equipment and systems search and locate information on a specific technological process establish the difference where more than one model or type of system can be implemented locate and evaluate technical literature to supplement data to keep abreast of current related technology	Information extracted from catalogues, handbooks and manuals will be used to select a system and/or equipment which best meets customer requirements. Engineering data will be used to support and clarify the basis of final selection of system and/or equipment.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard
		extract required data to: . size HRA units . check air and refrigerant properties . check operating parameters against design estimates . select replacement units . select estimate factors	

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
2	communicate effectively	converse effectively by telephone and face to face through the use of various techniques prepare written reports develop verbal ability to express meanings and uses of technical terminology and ideas associated with them consult with manufacturers and sales people present technical reports when called upon at meetings with sales, customer and/or installation groups liaise with sales people and sometimes accompany them as a technical consultant for the purpose of cost build-up make occasional decisions as to where equipment will be purchased coordinate with product control for delivery dates on specific equipment	The designer will: . communicate using the most effective medium for maximum results; . function as part of a technical team; . create a rapport with other departments; . satisfy sales personnel requests for general information and clarification of specifications.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
3	answer enquiries from: . engineers . architects . contractors . salespersons . building owners . system operators	interpret enquiries and provide supplementary information on: . features and capabilities of equipment . dimensional requirements . mounting methods . operation of units . comparison of units . unit installation . heating or cooling capacity of equipment . types of units . required power supply of units . specific capacities not shown on charts, such as: - air across evaporator coil - room load - humidifier sizing for electronic humidifiers determine from symptoms the probable cause of system problems investigate problems in field if necessary	Responses to enquiries will be prepared clearly and concisely, in composition and form, to suit the originator and with sufficient supportive documentation to satisfy the original request.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
4	read and interpret: . building working drawings, mechanical and architectural . specifications, requirements and contracts . schematics	identify and interpret: . numerical values and their associated units . dimensions . the title block and scale . orthographic and isometric projections . pictorial drawings . abbreviations, signs and symbols . wiring diagrams . building structure identify and apply data for load calculations interpret and analyze piping and duct layout analyze competitors heating, refrigeration and air conditioning systems	Data extracted from prints, schematics and diagrams will be used to: . determine installation procedures; . determine mounting area and establish mounting methods; . aid in the selection of HRA systems and components; . determine equipment location; . determine layout of piping, ducting and simple controls; . calculate load requirements. Customer requirements will be interpreted appropriately leading to the correct identification of the system, equipment units or necessary modifications.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
5	read and interpret charts, graphs and tables	identify and interpret data such as: . specific heat . temperature, pressure and humidity . design temperature coefficients . heat transfer coefficients . capacities and maximums . differentials . correction factors . relationships (temperature/pressure/ enthalpy) . recommendations identify and apply data for the selection or sizing of: . wiring and piping . equipment . replacement parts extract required data for load calculations interpret critical path analysis charts understand the basic psychrometric loop identify and interpret the following data on psychrometric charts: . dry bulb temperature . wet bulb temperature . relative humidity . pressure . dew point . moisture content of air understand properties of air in relation to the design and operation of HRA systems understand advance psychrometrics: . sensible and latent heat . air mixture . return air and outdoor air . treatment of air passing through plenum	Graphs, charts and tables will be used to extract data for: . equipment selection; . refrigerant and air handling units sizing; . checking operating parameters against design estimates; . evaluating system elements and individual equipment units. Psychrometric charts will be used to understand air conditioning processes.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
6	assess energy conservation factors	determine the availability of energy supply select a system which best meets the current requirement for the conservation of energy identify the limitations of different modes of energy interpret and apply standards, codes and regulations governing energy develop an awareness and general understanding for energy conservation in such areas as: . equipment operating efficiencies . system design . building envelope design . product preparation . energy recovery devices identify the various existing computer programs and their use in calculating energy savings	The selection of a system and/or equipment units will be based upon: . adaptability to different modes of energy; . energy conservation factors; . pollution standards. Economics and efficiency factors associated with different modes of energy and conservation requisites will be stated for both long- and short-term considerations.

SPECIFIC PERFORMANCE OBJECTIVES AND CRITERIA FOR

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
7	estimate load requirements, heat gain and heat loss for buildings, including: . commercial . residential . industrial . institutional	determine: . use of area to be conditioned . operating period of system in hours per day . annual weather variations of the locality . building orientation (NSEW) calculate heat gain or heat loss through walls, floors and ceilings depending on the: . type and material of construction . area exposed to a different temperature . type of insulation . thickness of insulation calculate heat loss due to: . conduction . transmission . leaks calculate heat gain from sun calculate heat and moisture load from: . appliances . ventilating air . occupants . domestic processes carried out in the conditioned area . infiltration air identify from drawings the physical dimensions of building compute overall rate of heat transfer (U factor) through: . walls . ceilings . roofs	Load requirements will be determined by taking into consideration the factors necessary to ensure safe and effective operation of selected equipment. Load limits and optimal operating characteristics will be included in the estimate. Load requirements will be estimated according to: . personal comfort; . safety; . efficiency; . operating cost.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
		use heat transfer equation for load calculation purposes determine product load using tables of product data utilize standard load calculation forms such as: . heat loss table . heat gain table . heating data sheets . cooling data sheets and determine the limitations in their use	

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
8	sketch working drawings	select and use standard drafting tools and equipment such as: . mechanical pencils and lead . T-squares . triangles . lettering guides . lettering pens . dividers . drawing board . calculator or slide ruler develop and become efficient on basic drafting skills draw floor plans, simulate existing floor plans read requests for working drawings sketch mechanical drawings such as: . site plans (occasionally) . plumbing and drainage . heating and ventilating . isometric piping drawing sketch out basic designs of equipment and/or systems, according to customer requirements trace and sketch layout of complete system gather information on specifications and/or requirements from engineer and sales department read and understand blueprints of building layouts: . floor plan . cut away sections . front, side and rear elevations	Working drawings and related documents should be prepared according to drafting principles, using standard drawing symbols, as well as special symbols used in heating, refrigeration and air conditioning.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
9	determine control requirements, such as: - electrical - electronic - pneumatic - mechanical	understand control systems functions read simple wiring diagrams and understand the functions involved identify and interpret electrical drawing symbols dictate basic L.V. wiring requirements of HRA systems determine mounting methods of system control determine control system tolerance range convey system control requirements to control companies identify and understand simple electrical wiring diagrams for: . relays . switches . lighting . controls associated with HRA systems consult with electricians for interference and problems in the wiring layout of equipment determine controls to conform to a specific heating system	Control requirements will be determined according to: . customer relative needs; . equipment ratings and specifications; . safety standards; . codes and regulations. Control requirements will provide a system operation that meets design requirements.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
10	select a system, such as: . heating . refrigeration . air conditioning . ventilation	understand the operation of HRA systems with emphasis on variables such as: . temperature . pressure . humidity . air flow . air filtration . power supply determine from customer requirements and specifications: . system type . capacity . dimension . mode of operation understand the function of duct work and its use in HRA systems select type of duct work identify the various types of HRA and ventilating systems	System selected will be functionally identified as especially suitable or compatible for specific customer application. System selection will be based on: . customer relative needs; . standards, codes and regulations; . load requirements; . maintenance and operating costs.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard
11	design an HRA system, such as: . residential . commerical . industrial . institutional	develop an intimate knowledge of the equipment needed understand and evaluate construction and mechanical drawings, for example, . room layouts . building structure, taking into consideration: - joints - insulation - bearing walls - etc. determine layout and size: . equipment . ducting . piping . system controls . drainage . equipment hook-up determine fuel facilities available in the area identify types and measuring methods of air filtration determine from blueprints, charts, manuals and specifications: . areas needing ventilation . air quantity required . methods of air distribution to be used . if air reclaim is necessary . pipe size use a duct calculator	System design will conform to: . CSA specifications; . Hydro requirements; . U.L. specifications; . local codes and regulations; . safety standards. The system design, according to its use, will take into consideration: . personal comfort; . health requirements; . safety; . convenience; . cost requirements; . customers specifications. Duct work will be designed to accomplish: . minimum space requirements; . minimum cost; . acceptable performance; . noise and vibration reduction; . minimum duct length; . minimum number of elbows and fittings.

SPECIFIC PERFORMANCE OBJECTIVES AND CRITERIA FOR			
NO.	**TERMINAL PERFORMANCE OBJECTIVES** **To be able to:**	**ENABLING OBJECTIVES** **Will be able to:**	**TERMINAL PERFORMANCE CRITERIA** **Minimum acceptable standard:**
		identify and apply duct sizing methods, including: . velocity method . constant pressure drop method . static regain method determine: . air movement required in each room . supply air temperature . sizes of the various sections of duct system . register outlets recommend size and type of insulation to be installed sketch complete layout of system and obtain feedback on design acceptance design a pneumatic system translate designs to drawing board produce final plan prepare operating, installation and maintenance manuals design electrical schematics) These skills print refrigeration schedules) are used infrequently.	

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
12	modify an HRA system design	determine the adaptability of the existing system perceive by visualizing the layout and operation of equipment in existing installations and identify the effects of system modifications design prototype with required modifications solve problems for required modifications determine modifications of duct work to eliminate noise and vibrations determine energy savings due to modifications	System design modifications will conform to: . standards, codes and regulations; . customer requirements. Modifications of a system design will provide: . personal comfort; . safety; . convenience; . correct product refrigeration

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
13	select equipment for a heating system such as: . electric heaters . burners . storage tanks . combustion chambers . furnaces . boilers . dampers . system controls . air handling and distribution equipment . piping and tubing	identify the various types of equipment used in heating understand the functions of each individual equipment and their use in heating select equipment to meet job specifications according to: . working drawings . ratings . capacities . dimensions . location of installation select the correct substitute of an equipment use furnace rating handbooks determine size of piping and tubing to be used with equipment write specification manuals for equipment selected determine duct work and select proper outlet terminal devices price equipment	Equipment for a heating system will conform to: . CSA requirements; . Hydro requirements; . U.L. requirements and specifications; . local codes and regulations. Equipment selection will be based on: . customer requirements; . compatibility with competitors products; . load requirements; . manufacturer's specifications.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
14	select equipment for a ventilating system	identify existing ventilating system as: . natural . mechanical determine ventilating air volume determine type and size of: . supply fans . exhaust fans calculate ventilation requirements determine need of supplementary air openings if ventilation is inadequate select air ducts to carry air from outside select louvres, grills and screens	Ventilating equipment will be selected to provide proper circulation of air. Equipment selected will conform to: . CSA requirements; . U.L. specifications and requirements; . local codes and regulations; . building regulations; . personal comfort; . customer requirements.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
15	select equipment for refrigeration systems such as: . compressors . evaporators . condensers . coolers . coils . metering devices . system controls . piping tubing . etc.	identify the various types of equipment used in refrigeration understand the function of each individual piece of equipment and its use in refrigeration select controls to conform to a specific refrigerating system understand function of controls with relation to system operation select compressor and evaporator for the proper operating temperature difference identify capacities and maximums of equipment select correct substitute of air equipment select equipment for appropriate air handling and distribution use compressor capacity curves determine size of piping and tubing to be used with equipment write specification manuals for equipment selected determine mounting methods of equipment price equipment	Equipment selected will: . conform to safety standards, codes and regulations; . functionally be identified as especially suitable for specific customer application. Equipment selection will be based on refrigeration load requirements.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
16	select equipment for air conditioning systems such as: . compressors . evaporators . condensers . receivers . metering devices . system controls, piping and tubing . air handling and distribution equipment . etc.	identify the various types of equipment used in air conditioning understand the function of each individual piece of equipment and its use in air conditoning select controls to conform to a specific air conditioning system understand function of controls with relation to system operation determine duct work and select proper outlet terminal devices select proper type of pressure regulators identify capacities and maximums of equipment use compressor capacity curves determine size of piping and tubing to be used with equipment select correct substitutes of an equipment determine mounting methods of equipment write specification manuals for equipment selected price equipment	Equipment selected will: . conform to safety standards, codes and regulations; . functionally be identified as especially suitable for specific customer application. Equipment selection will be based on: . customer requirements; . compatibility with competitors products; . load requirements; . manufacturers' specifications.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
17	maintain records of work	read, write and file design data ascertain precisely the information required from each design for record purposes utilize applicable manual filing system and methods for efficient operation cross-reference, retrieve and store files maintain a current file on active transactions requiring monitoring by the sales person	Records should be stored in the correct place according to the system in use. The systems designer will gather necessary data for completing designs by retrieving the appropriate files and information.

NO.	TERMINAL PERFORMANCE OBJECTIVES To be able to:	ENABLING OBJECTIVES Will be able to:	TERMINAL PERFORMANCE CRITERIA Minimum acceptable standard:
18	check field work	check field work whenever necessary, to assure equipment is applied correctly and work is done according to plans and specifications advise the field work superintendent on problems arising during installation go out to assist in solving system problems when requested by servicers	Field survey should be carried out periodically to gather general information and check unusual operating conditions.